3.1.2 Change of state

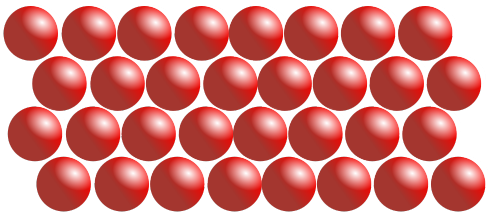
videos

Matter exists in four states – solid, liquid, gas and plasma. At GCSE we are only concerned with the first 3.

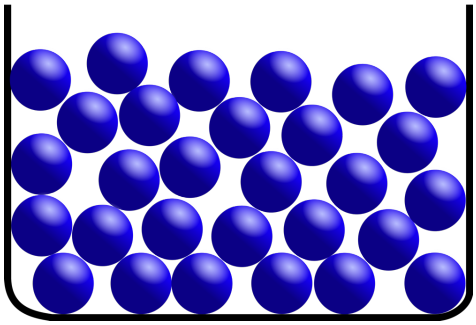
When materials are heated or cooled, they can change from one state to another. A change of state is a physical change, and reflects changes in the particle arrangement, particle movement and the forces of attraction between particles. (Note: We use the term 'particle' to mean atoms in atomic materials (e.g. copper), and molecules in molecular materials (e.g. H_2O).)

The particle model of matter

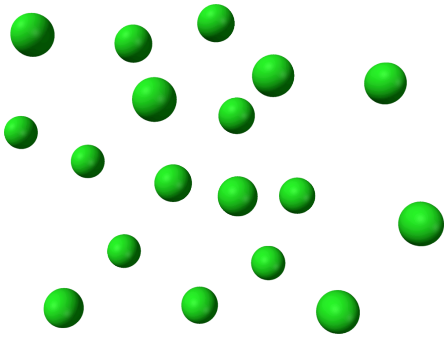
We can better understand change of state by using the particle model of matter:



In a solid, particles are closely packed. The force between particles is strong, so particles are held in fixed positions. The particles vibrate around an equilibrium position. The higher the temperature, the more vigorously the particles vibrate.



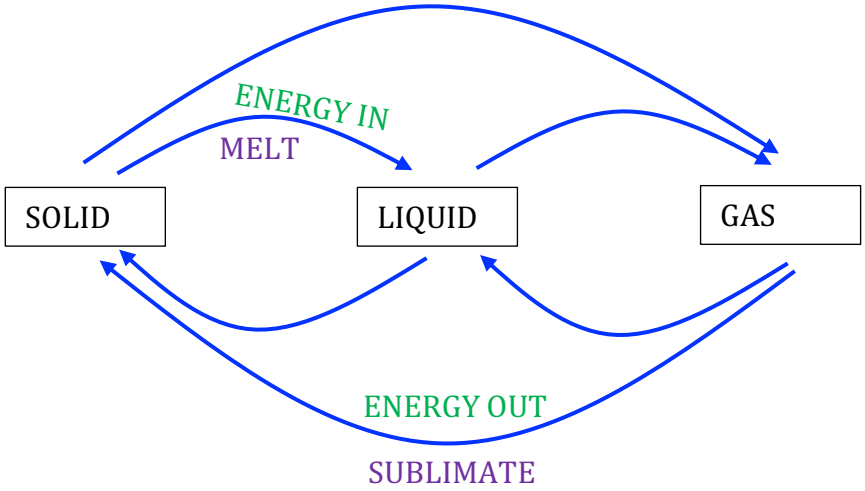
In a liquid, particles are closely packed. The force between particles is weaker, so particles can move around, and slide past each other. The higher the temperature, the faster the particles move around.



In a gas, particles are widely spaced. The force between particles is very weak, so particles can move around freely and rapidly. The higher the temperature, the faster the particles move.

(1) Solids often become less dense when they are heated. How can this be explained using the particle model of matter? (Hint: Think about the formula for density. What factor would decrease the density?)

(2) Complete the following diagram, using the following: ENERGY IN, ENERGY OUT, BOIL, SOLIDIFY, MELT, SUBLIMATE, CONDENSE.



(3) Describe, using the particle model, the change of state from a solid to a liquid. Describe how the particle arrangement, particle movement and inter-particle forces change during melting.

Evaporation (not to be confused with boiling)

Evaporation occurs at the surface of a liquid well below the boiling point of the liquid. Liquid particles are in continuous motion. They have kinetic energy. Some of the liquid particles will have enough kinetic energy to break free from the inter-particle bonds in the liquid. These particles then can escape from the

surface of the liquid and become a gas. Only the most energetic particles in the liquid can do this. The result is that the average kinetic energy of particles left in the liquid is decreased, lowering the temperature of the liquid. The liquid will absorb heat energy from its surroundings.

(4) ✎ Why does sweating help us to cool down? (Hint: Think about where the energy can come from to replace the energy lost in the sweat through evaporation.)

(5) ✎ If evaporation cools a liquid, why don't they just get colder and colder? (Hint: Heat energy flows from warmer to cooler areas.)